

unpatentable over claims 1-20 of U.S. Patent No. 6,449,081 B1 (Onuki). These rejections are respectfully traversed.

The present invention provides an arrangement within an optical element that increases the curvature radius of the boundary formed by two kinds of liquids employed therein. This arrangement allows to reduce the thickness of the apparatus employing such an optical device.

Berge is directed to a variable focus lens. This reference discloses a chamber filled with a first liquid and a drop of a second liquid disposed at rest on a region of a first surface of an insulating wall of the chamber. The first and second liquids are not miscible, have different optical indexes and are of substantially the same density. The first liquid is conductive and the second liquid is insulating. The lens further comprises a means for applying a voltage between the conductor liquid and an electrode placed on the second surface of said wall.

While Berge discloses two liquids and an electrode, it, however, fails to disclose or suggest that the electrode is ring-shaped to surround at least one of the two liquids. Further, this reference does not disclose or suggest enlarging the curvature radius of the boundary by setting the angle ψ . Accordingly, it is clear that Berge cannot affect the patentability of the presently claimed invention.¹

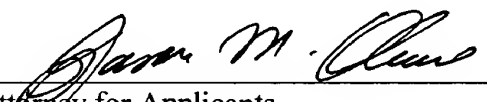
¹/Berge corresponds to U.S. Patent No. 6,369,954 B1, which is enclosed herewith for the Examiner's convenience. Applicants reviewed this patent and respectfully submit that the presently claimed invention is patentable over it for the same reasons as those discussed above in connection with Berge.

Onuki is directed to an optical element. However, the claims in this patent do not disclose or suggest a ring-shaped electrode to surround the first and/or the second liquid. Accordingly, the present claims are patentably distinct from the claims in Onuki.

Wherefore, it is respectfully requested that the outstanding rejections be withdrawn and the subject application be passed to issue.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All correspondence should continue to be directed to our address given below.

Respectfully submitted,



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APPENDIX

Application No. 09/783,072
Attorney Docket No. 03500.015131

IN THE CLAIMS:

Claims 1, 2, 17-20 and 30-32 have been amended as follows:

1. (Amended) An optical device comprising:

an optical element having a container and first and second liquids contained sealingly in said container, said first and second liquids being substantially equal in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids differing from each other in transmittance, said first and second liquids making the boundary between said first and second liquids having a predetermined shape; and

an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids.

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between a side surface of the container and the boundary between said first and second liquids.

2. (Amended) An optical device comprising:

an optical element having a container and first and second liquids contained sealingly in said container, said first and second liquids being substantially equal in refractive index, said first and second liquids existing without mixing with each other, said first and second

liquids differing from each other in transmittance, said first and second liquids making the boundary between said first and second liquids having a predetermined shape;

an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids; and

a voltage application circuit for applying a voltage to said electrode,

wherein the shape of the boundary between said two liquids is changed by application of a voltage through said electrode to change the quantity of transmitted light in the bundle of rays passing through said optical element, and

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between a side surface of the container and the boundary between said first and second liquids.

17. (Twice Amended) An optical system in which an image is formed on an image formation plane through a lens element, said optical system comprising at least one of a diaphragm and a shutter incorporated in said lens element,

wherein said at least one of the diaphragm and the shutter is formed by an optical element having a container and first and second liquids contained sealingly in said container, said first and second liquids being substantially equal in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids differing from each other in transmittance, and said first and second liquids making the boundary between said first and second liquids having a predetermined shape, [and]

wherein an electrode is formed in said optical element in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids, and

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between a side surface of the container and the boundary between said first and second liquids.

18. (Amended) A photo-taking device comprising:
- an imaging optical system for forming a subject image;
 - an optical element for changing the quantity of transmitted light in a bundle of rays passing through said imaging optical system;
 - image pick-up means for recording the subject image;
 - said optical element having a container and first and second liquids contained sealingly in said container, said first and second liquids being substantially equal in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids differing from each other in transmittance, said first and second liquids making the boundary between said first and second liquids having a predetermined shape;
 - an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids; and
 - a voltage application circuit for applying a voltage to said electrode,

wherein the shape of the boundary between said two liquids is changed by application of a voltage through said electrode to change the quantity of transmitted light in the bundle of rays passing through said optical element, and

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between a side surface of the container and the boundary between said first and second liquids.

19. (Amended) An optical device comprising:

an optical element having a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in transmittance, said first and second liquids existing without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape; and

an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids,

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between the side surface of the container and the boundary between said first and second liquids.

20. (Amended) An optical device comprising:

an optical element having a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in transmittance, said first and second liquids existing without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape;

an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids; and

an application circuit for applying a voltage to said electrode,

wherein the shape of the boundary is changed by application of a voltage to change the refractive power with respect to light passing through said optical element, and

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between the side surface of the container and the boundary between said first and second liquids.

30. (Twice Amended) An optical system in which a predetermined image is formed or light of the image is converged by a lens element, said optical system comprising a variable-power element incorporated in the lens element,

wherein said variable-power element has a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in refractive index, said first and second liquids existing without mixing with each other, and said

first and second liquids making the boundary between said first and second liquids having a rounded shape, [and]

wherein an electrode is formed in said variable-power element in such a place as to avoid interference with passage of a bundle of rays incident upon said variable-power element, said electrode being ring-shaped to surround at least one of said first and second liquids, and

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between the side surface of the container and the boundary between said first and second liquids.

31. (Amended) An optical system in which a predetermined image is formed or light of the image is converged by a lens element, said optical system comprising:

an optical element constituting a portion of said optical system, said optical element including a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape; and

an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids,

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact

angle between the side surface of the container and the boundary between said first and second liquids.

32. (Amended) A photo-taking device comprising:

an imaging optical system for forming a subject image:

a variable-power optical element incorporated in said imaging optical system, said variable-power optical element including a container having a side surface inclined at a predetermined angle from an optical axis, and first and second liquids contained sealingly in said container, said first and second liquids differing substantially from each other in refractive index, said first and second liquids existing without mixing with each other, said first and second liquids making the boundary between said first and second liquids having a rounded shape;

an electrode formed in such a place as to avoid interference with passage of a bundle of rays incident upon said optical element, said electrode being ring-shaped to surround at least one of said first and second liquids; and

image pick-up means for recording the subject image,

wherein an angle ψ is set so that a curvature radius of the boundary between the first and second liquids becomes large, where said angle $\psi = 90^\circ - \theta$, with θ being a contact angle between the side surface of the container and the boundary between said first and second liquids.